Version EP/4

EGT3
ENGINEERING TRIPOS PART IIB

Monday 1 May 2023 2 to 3.40

Module 4M21

SOFTWARE ENGINEERING AND DESIGN

*Answer not more than **three** questions.*

All questions carry the same number of marks.

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

*Write your candidate number **not** your name on the cover sheet.*

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed
Engineering Data Book

10 minutes reading time is allowed for this paper at the start of the exam.

You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.

You may not remove any stationery from the Examination Room.

1 (a) Explain what is meant by polymorphism in the context of object oriented design. Give a specific example to illustrate the benefits of polymorphism. [10%]

(b) A financial technology company has an online payment system that allows their customers to transfer funds internationally. A customer can access the system using their username and passcode, and then make a payment from their account to another customer's account.

(i) Propose a software design for the system described above. Provide an illustration of the design with the help of a class diagram. [20%]

(ii) Draw a sequence diagram to demonstrate the scenario of a customer logging into the system using their username and passcode, and making a payment from their account to another customer's account. [30%]

(c) A new anti-money laundering (AML) feature is added to the system described in (b), which screens every completed transaction and, when applicable, generates suspicious activity reports (SARs). Additionally, a separate fraud check is introduced to analyse the fraud risk of each payment after it is processed. Extend your software design to introduce this additional functionality. Update the class and sequence diagrams to illustrate this extension. [40%]

2 (a) Describe the key processes in the software lifecycle. [10%]

(b) A company that produces emergency-response drones is planning to develop a new computer-aided dispatch system that allows a drone to be dispatched to deliver vital supplies in emergency situations.

(i) It is not uncommon for software projects to fail. Discuss the consequences of a potential failure of the emergency-response drone dispatch system described above. [20%]

(ii) Give an example of a large software system failure in the past that could serve as a relevant reference point. Describe in detail the main lessons learnt from it. [30%]

(iii) Assess the extent to which the lessons in (b)(ii) are still relevant today. Suggest the software development process for the emergency-response drone dispatch system, including specific software management techniques and practices that can be employed to minimise the risk of software failure. [40%]

3 A company has a large amount of semi-structured data in a spreadsheet that frequently needs to be copied into a wide variety of forms with different formats. The designs of these forms are outside the company's control and their exact structure and input requirements tend to change over time. To improve worker efficiency, the company wishes to use a programming by example system to enable this task to be automated by the worker for a particular form. The idea is that the worker fills out the form a few times and then the system learns how to perform this task.

(a) Identify a system boundary and motivate the choice of boundary. [10%]

(b) State and motivate the type and appropriate level of automation for this task. [10%]

(c) Describe the primary and secondary evaluation criteria for automating this task. [20%]

(d) Explain what a mixed-initiative interface is and propose three principles for mixed-initiative interfaces that are particularly important for this task. Briefly justify each principle. [40%]

(e) Propose a method for assessing the key risks in this system. Motivate your answer. [20%]

4 A design team has created a new function access method for a mobile phone that allows a user to trigger functions by tapping the sides of the phone. For example, tapping the phone on the top starts the camera app while tapping the phone on the top-left side increases volume. Detection is carried out using a machine learning algorithm that infers a tap location using the phone's built-in sensors.

(a) Accessing a note taking app can normally only be done by unlocking the phone, accessing the main page, opening a folder called "Utilities", and then clicking on the note taking app icon. Now, assume that using the new function access method the user can instead access the note taking app directly by unlocking the screen and tapping the bottom of the phone. Use a Keystroke-Level Model GOMS (KLM-GOMS) analysis to estimate the time it will take an expert user to access the note taking app using both methods. Propose the operators required for analysis and estimate their durations. Explain the limitations of this analysis. [30%]

(b) Discuss possible usability issues and mitigation strategies of the new function access method by referring to the following three heuristics: (1) user control and freedom; (2) error prevention; and (3) recognition rather than recall. [30%]

(c) The design team wants to investigate whether it is possible to collect empirical evidence that the new function access method is more efficient than the traditional function access method on the mobile phone. They recruit 16 participants for a within-subjects experimental design study to be carried out in their usability lab. They introduce one independent variable Function Access Method with two levels: Old Function Access Method, New Function Access Method. The dependent variables are: (1) time to trigger a function; and (2) accuracy. The design is counter-balanced. Participants are instructed to trigger commands as quickly and as accurately as possible from a set of eight representative commands that are presented repetitively to the participant in random order. Each session for each condition lasts 20 minutes.

(i) Explain whether there is a high risk of an asymmetrical skill-transfer effect in this experimental design. [10%]

(ii) Relating back to the heuristics in (b), discuss the internal and external validity of this experimental design. [30%]

END OF PAPER

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